MARINE RAIN PREDICTION USING ENHANCED DEEP LEARNING TECHNIQUES

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Synopsis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641043

In partial fulfilment of the requirements for the Degree of

Doctor of Philosophy in Computer Science

AUGUST 2023

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1. INTRODUCTION

Weather forecasting is the science application to predict the atmospheric conditions for a given location as well as time. In that, the marine weather forecasting is highly essential for analysis of climate in the ocean environment. The marine weather data classification is the most considerable task for minimizing the issues on urban metropolises. The different features used to classify the data are, latitude, longitude, zonal winds, meridional winds, relative humidity, air temperature and sea surface temperature. To effectively capture deep temporal characteristics and discover the temporally fluctuating connection of wind speed time series, a novel deep learning-based model that combines the Discrete Wavelet Packet Transform (DWPT) and Bi-Directional Long Short-Term Memory (BLSTM) (Amirhossein Dolatabadi *et al*., 2020) is created.

The model analysis and re-analysis, satellite data, and expedition-related observations are used to evaluate the error increase. In the model forecasts, the observed variability of sub seasonal rainfall linked with mid-latitude systems is found to display eastward propagations (Anitha Gera *et al*., 2022). Three different approaches are used in the framework's development to forecast monthly Electronic Data Interchange using univariate, multivariate with nearby spatial points and the Sea Surface Temperature (SST) Eigen Vector values. The addition of the SST Eigen Vector values has also been shown to improve the detection of really wet episodes (Anshuka Anshuka *et al*., 2022).

The error in the numerical weather prediction models caused by the interplay of many physical processes is studied using machine learning approaches in this work (Azam Moosavi *et al*., 2021). The study investigates and analyses the seasonal lag association between ENSO and NAO. Both short-term forecasting and long-term prediction of the NAO fluctuation have taken into account for the interaction. Using the Nio indices based on the RF-Var model, the monthly NAO index (NAOI) fluctuation is predicted, and the accuracy is 68% when the lead time is roughly three months (Bin Mu *et al*., 2021).

Several research methods are performed on data mining methods for estimating performance of marine forecasting. But the accurate prediction with minimum time and error is a challenging issue. The performance of weather data prediction is the major goal of data mining to attain decision-making processes for disasters. In the existing techniques with the Ensemble experiment method-based weather prediction accuracy was higher, whereas, the error rate during the pre-processing technique is also considered to be higher. Then the existing U-Net based deep learning framework pre-processing time was also considered to be very high (Jesus Garcia Fernandez *et al*., 2021).

Again, the Scalable Parallelizable Induction of Decision Tree (SPRINT) algorithm-based climate data pre-processing was employed with the higher time consumption. Finally, the existing Small-range of weather prediction was attained through WRF scheme. However, it has high computational cost (Paulo S. G. de Mattos Neto *et al.,* 2022). The 2D-convLSTM network model was not developed with accurate level of weather prediction, and the Deep Neural Network (DNN) technique also failed to get more accurate weather prediction range (Pradeep Hewage *et al.,* 2021). To reduce the gap between these techniques, the research work proposes the techniques that enhance the marine rain weather forecasting with improved accuracy and with minimum time and error rate that can work towards solving the above-mentioned issues. The research problem is thus formulated as below.

"Prediction accuracy must be increased when a huge volume of data is taken into account and also to improvise the Marine Rain Prediction, using enhanced deep learning technique with Multi-variant features, where the time taken and the error rate can be reduced."

In order to find solution to the above problem statement, the primary objective of the research work is to:

- "Improve the Marine Rain Prediction using enhanced deep learning techniques".

Further, to meet out the above-mentioned primary objective, the following specific objectives are set forth herein below to:

- Enhance pre-processing technique for improving the performance of marine weather data,

- ❖ Perform feature selection to extract optimal features from multiple entities, which helps to enhance be efficient, and
- ❖ Design enhanced classification techniques to improve the performance of Marine Weather Rain Prediction.

2. RESEARCH METHODOLOGY

The Multi-objective grasshopper optimization without negative constraints performed into Ensemble empirical mode decomposition was used for achieving accurate prediction result. The performance has been measured by considering short-term time series with Wind Speed (Xinsong Niu *et al.,* 2019). The Extended U-Net architecture was designed by employing the residual connection, parallel convolution as well as asymmetric convolution and the handled data is based hour-wise (Jesus Garcia Fernandez et al., 2021). In this research, three techniques are proposed which involves data pre-processing, feature selection and classification as the most important process.

In the proposed research, the data pre-processing is divided into data quality assessment, data cleaning, data reduction and data transformation. The Data processing techniques were introduced to tackle the data imbalance problems by considering the Short-term rainfall method through employing the deep belief network. Then the classification forecast model is used for short-term intensive rainfall (Huosheng Xie *et al.*, 2021). In this investigation, the Feature Selection is performed to select target features. A novel Spatial Feature Attention Long Short-Term Memory method was proposed with the intention of obtaining multiple meteorological features spatial as well as temporal relations towards temperature forecasting (Masooma Ali Raza Suleman *et al*., 2022). In the proposed research, the classification is performed to predict the weather condition with rain or no rain classes for accurate forecasting.

All these phases contribute by integrating the techniques, namely, for pre- processing, the Ridge Regularized Imputed Scaled Clipping Normalization (RRISCN) Technique is proposed, and then for feature selection, the Fisher Kernel Target Projective (FKTP) Technique is proposed. Finally, for classification, the Reinforced LSTM Partial Differential Quantum Hamiltonian Neural Network (ReLSTM-PDQHNN) Technique is proposed.

2.1 Phase I: Pre- Processing

The performance of data pre-processing is carried out for predicting the marine weather conditions and climate analysis from marine weather dataset. The estimation of marine weather data is a major assignment in meteorological research and weather forecast. The atmospheric conditions are determined for forecasting weather data at a specific given location and time.

2.1.1. Ridge Regularized Imputed Scaled Clipping Normalization (RRISCN) Technique based Pre-Processing

The various deep learning and machine learning techniques are highly utilized for predicting marine weather data with the better quality of forecasting results. For efficient marine weather forecasting, the pre-processing process is carried out. The noisy weather data is removed to forecast the marine weather effectively with minimized complexity. The effective performance of pre-processing helps to provide the better results in prediction of weather data with higher accuracy. From large marine weather dataset, noisy data is removed, and missing values are filled during pre-processing. Simply, the process of cleaning and organizing the marine data is described as pre-processing. With the support of pre-processed data, marine data classification is performed for better forecasting.

Therefore, Ridge Regularized Imputed Scaled Clipping Normalization Pre-processing (RRISCN) technique is proposed for performing the data pre-processing from considerable weather dataset. Based on the process of data quality assessment, data cleaning, reduction and data transformation, pre-processing is performed. This helps to remove the noisy marine weather data and filling the missing values in dataset. The developed deep learning techniques comprise of various layers, namely, one input layer, four hidden layers and one output layer for efficient pre-processing. From the taken marine weather dataset, the number of marine weather data points are considered as inputs, and it has been presented in the input layer. Following this, the input data is fed into hidden layer to perform the pre-processing process. In the first hidden layer, data quality is assessed using Ridge Regularized process. The data quality is assessed with the identification of mismatched data types, mixed data values and data outliers. Following this, the data cleaning is performed at second hidden layer by using Imputed nearest neighbor interpolation. During the cleaning process, missing data values are filled through approximating the feature value. In the third hidden layer, point-

wise animator correlation analysis is applied for performing data reduction process. The data reduction is carried out to eliminate the duplicate marine weather data from the dataset. In the fourth hidden layer, data transformation is performed through the scaled clipping normalization process. Lastly, an efficient pre-processed data is resulted at the output layer with higher accuracy and minimized time. Hence, The RRISCN technique pre-processes marine weather data instances from the considered dataset. Thus, it improves the performance of prediction accuracy for efficient result in marine weather dataset. The experimental work of proposed method is conducted on factors, namely, pre-processing accuracy, pre-processing time and space complexity. The performance analysis of the proposed RRISCN technique improves the accuracy on pre-processing with minimum time and complexity effectively. The algorithmic process of RRISCN technique to perform data pre-processing is explained in this section.

Algorithm

Ridge Regularized Imputed Scaled Clipping Normalization (RRISCN) Technique for Pre-Processing

Input: Marine weather data
Output: Pre-processed marine weather data
Begin
Step 1: Collect the number of marine weather data

Step 2: For each marine weather data in dataset

Step 3: Perform marine weather data quality assessment through ridge regularization

Step 4: Perform marine weather data cleaning using Imputed nearest neighbor interpolation

Step 5: Find missing feature of marine weather data

Step 6: If missing feature value in respective column feature then

Step 7: Approximate neighbor value of particular feature

Step 8: End if

Step 9: Perform Data reduction through tanimoto similarity

Step 10: If duplicate value in the dataset then

Step 11: Remove the feature value

Step 12: End if

Step 13: Apply scaled clipping normalization for data transformation

Step 14: Return (pre-processed marine weather data) at the output layer

Step 15: End for
End

2.2 Phase II: Feature Selection

The performance of data forecasting is enhanced with the use of a feature selection process. During the feature selection process, relevant features that reduce the risk occurred during the prediction of marine data are determined. The presence of unrelated features causes more significant problems and needs to be more accurate in data forecasting.

2.2.1. Fisher Kernel Target Projective Feature Selection Technique

In order to predict marine weather, Fisher Kernel Target Projective Feature Selection (FKTP) technique is developed. The main aim of the proposed technique is to forecast marine weather data instances with higher accuracy through the feature selection process. With the help of obtained pre-processed marine data, the feature section process is performed in the designed proposed technique. Initially, several marine weather data are considered as input from the dataset. For each input data, pre-processing is carried out to remove noise data from the dataset through the Ridge Regularized Imputed Scaled Clipping Normalization process. With obtained pre-processed data, feature selection is presented to select significant features. Here, relevant significant features are selected using a Fisher Kernel Target Projective feature selection process. The maximum likelihood value is measured between features to identify relevant and irrelevant features. Eliminating irrelevant features minimizes time to forecast weather data and helps attain accurate data classification. Based on the estimated likelihood function, Fisher Kernel output is predicted to select features with higher accuracy and minimized error. With feature selection results, the performance of marine weather data is predicted with enhanced accuracy based on dimensional space. Thus, it helps to improve the accuracy of data prediction with minimum time and complexity. Hence, the proposed FKTP technique conducts the experimental works on parameters such as feature selection accuracy,

feature selection time, error rate, and space complexity. The experimental result shows that the proposed technique achieves higher accuracy with reduced time and error rate than the state of art methods. The algorithmic process of Fisher Kernel Target Projective Feature Selection Technique is explained in this section.

Algorithm **Fisher Kernel Target Projective Feature Selection Technique**
Input: Big time-series dataset and Number of features **Output:** Select the target features Begin 1. Collect the number of features 2. For each feature 3. Construct feature matrix 4. Measure the likelihood between the features 5. if then 6. Features are said to be a relevant 7. Project the target features into low-dimensional space 8. else 9. Remove irrelevant features 10. End if 11. End for End

2.3 Phase III: Classification

Predicting marine weather data performance is a significant process in meteorological organizations for forecasting big data performance at an early stage. The marine data forecasting performance is carried out to access the dataset's weather data. For the data prediction process, data classification plays a vital role in marine weather data mining. Before the weather data classification process, a feature extraction process is performed to minimize the complexity occurred data classification from the database. Utilizing the neural learning

network process provides more accurate predictions of mariner weather data. There are several ensemble classification techniques presented with various classifier processes. By classifying weather data, data attributes presented in the atmosphere at specific location and time is effectively predicted.

2.3.1. Reinforced Partial Differential Quantum Hamiltonian Neural Network ClassificationTechnique

Finally, ReLSTM-PDQHNN classification technique is introduced for rain prediction with combination of Reinforced LSTM as well as Partial Differential Quantum Hamiltonian Recurrent Neural Network (PDQHNN). For classifying better rain prediction selected features are considered by marine weather dataset. With considered input data points, Non-linear Autoregressive Exogenous-based Correlation model is presented for providing past values and current values respectively.

2.3.1. Reinforced Partial Differential Quantum Hamiltonian Recurrent Neural Network Classification

Several types of research are developed for predicting performance in meteorological organizations using different techniques. The analysis of marine weather data is complicated due to various data features. Using different data mining techniques, data forecasting analysis is performed. However, extensive data analysis's accuracy and time complexity could have been at the required level. Extracting relevant features is difficult because of cargo losses, injuries, and victims on weather data. The developed feature extraction techniques are performed with big data for predicting the performance of weather data with the help of different data mining techniques. However, the classification of the dependent and independent features needed to be revised. Thus, it improves the time taken to extract significant features from the dataset. Thus, data mining techniques with enhanced classification were presented to predict marine data with minimum complexity. Hence, the significant data classification issues are the need for achieving high-performance accuracy, more time to extract features, a high false positive rate, and so on. In order to overcome the above significant issues in mariner weather forecasting, an efficient ensemble classifier technique is introduced.

Therefore, the developed Reinforced Partial Differential Quantum Hamiltonian Neural Network (ReLSTM-PDQHNN) technique enhances marine weather forecasting through data classification. With the application of Reinforced Long Short-Term Memory (Reinforced LSTM) with Partial Differential Quantum Hamiltonian Recurrent Neural Network (PDQHNN), the proposed (ReLSTM-PDQHNN) technique is designed. At first, the Reinforced LSTM process is applied for marine weather forecasting. Back Propagation Time-based Weight update is applied to assign weight to input data. Subsequently, the Derivative Rectified Linear Unit activation function is performed to predict dimension inadequacy and retained decisions for accurate marine prediction. The PDQHNN-based classification process is presented for classifying weather data to achieve accurate prediction. For each wind data, the spatial correlation coefficient is estimated. The wind data are, zonal winds, meridional winds, humidity, air temperature, and sea surface temperature. Weather prediction is based on correlation value with an improved positive rate and minimized error rate. Thus, the ReLSTM-PDQHNN technique achieves higher accuracy of data performance forecasting with minimized time.

Algorithm

Reinforced Partial Differential Quantum Hamiltonian Recurrent Neural Network Classification Technique

Input: Dataset 'DS', Features 'F = $\{F_1, F_2, \ldots, F_n\}$', Observation 'O = $\{O_1, O_2, \ldots, O_m\}$'

Output: Robust classified results

Step 1: Initialize 'r − th' layer, 'n', 'm'

Step 2: Begin

Step 3: For each Dataset 'DS' with Features 'F' and Observation 'O'

Step 4: Formulate Quantum Hamiltonian function between adjacent hidden state weather resultas given in equation (12)

Step 5: Evaluate partial derivatives of the output with respect to sample signals as given in equation (13)

Step 6: Evaluate partial derivatives of the output with respect to activation function as given inequation (14) //process for classification

Step 7: If value (air temperature and sea surface temperature) lies between 20 and 30 degreesCelsius

Step 8: No prediction of rainStep 9: Return results

Step 10: End if

Step 11: If value (air temperature and sea surface temperature) less than 20 degrees Celsius andgreater than 30 degrees Celsius

Step 12: Prediction of rain

Step 13: Return results

Step 14: End if

Step 15: End for

Step 16: End

3. RESULTS AND DISCUSSION

The proposed research utilizes the marine weather data taken from the E1 NINO dataset. While performing marine weather forecasting, the efficiency of the three proposed techniques is established by consideration of different performance metrics, namely, pre-processing accuracy, pre-processing time, Pre-processing mean absolute error rate, Pre-processing space complexity, feature selection accuracy, feature selection time, space complexity, mean absolute error rate, classification time, classification accuracy, classification mean absolute error rate. The performance of proposed techniques with two existing technique of Pre-Processing is given in Table 1.

Table 1: Results of Pre-Processing Technique

PARAMETERS	**TECHNIQUE**		
	Multi-Objective Grasshopper Optimization	**Min-max Scaling**	**Proposed RRISCN**
Accuracy (%)	84.41	85.48	86.79
Time (ms)	2710	2580	2300
Space Complexity (MB)	210	200	167
Mean Absolute Error Rate (%)	12.66	9.39	5.33

From Table 1, it indicates that the performance of proposed RRISCN Technique achieved the best results when compared with the existing techniques in terms of Accuracy, Mean Absolute Error Rate, Time, and Space complexity.

Next, the Fisher Kernel Target Projective (FKTP) Feature Selection technique is designed to perform enhanced forecasting of marine weather data with higher accuracy and reduced time. With the aid of the Fisher Kernel Target Projection technique, the proposed method is designed, and the significant relevant features are determined for obtaining higher forecasting accuracy. The Performance Comparison for the two existing methods and proposed FKTP feature selection technique is presented in Table 2.

Table 2: Results of Feature Selection Techniques

PARAMETERS	TECHNIQUE		
	K-Means	**Multilayer Perceptron**	**Proposed FKTP**
Accuracy (%)	92.28	89.00	95.81
Time (ms)	5700	5840	4750
Space Complexity (MB)	200	182	150
Mean Absolute Error Rate (%)	5.7	7.8	3.5

From Table 2, it demonstrates that the proposed FKTP feature selection Technique achieved the better results when compared with the existing techniques with reference to Accuracy, Mean Absolute Error Rate, Time, and Space complexity in all methods.

The ReLSTM-PDQHNN classification techniques are introduced at last to improve the performance of marine weather forecasting with minimal time. Here, input sample data instances are considered for forecasting marine weather. The Performance Comparison of the proposed techniques with the two existing methods is portrayed in Table 3.

Table 3: Results of Classification Techniques

PARAMETERS	TECHNIQUE		
	Bi-LSTM	RNN-LSTM	Proposed ReLSTM-PDHNN
Accuracy (%)	95.03	93.05	97.07
Time (ms)	1180	940	890
Mean Absolute Error Rate (%)	1.22	1.05	0.44

Table 3 shows that the performance of the proposed ReLSTM-PDQHNN classification Technique obtained the most significant outcomes when compared with the existing techniques in respect of Accuracy, Mean Absolute Error Rate, Time, and Space complexity in all methods.

4. CONCLUSION

The performance of marine weather data prediction often causes an issue of feature extraction. During weather forecasting, relevant data feature is essential for better performance prevention. Managing weather data points in the environment improves atmospheric conditions and obtains efficient marine weather forecasting. Additionally, higher forecasting performance with minimum space complexity is one of the significant, issues to be addressed. In the phase I research work, the proposed RRISCN technique is carried out to perform the data processing with better accuracy and minimum time consumption, which aids in improving the outcomes for further data analysis. In phase II, the proposed FKTP feature selection technique is designed to accurately select the relevant features in a shorter amount of time with less space complexity for efficient weather forecasting. In the phase III research work, the proposed ReLSTM-PDQHNN technique is implemented to achieve improved results in marine weather prediction faster through the successful performance of weather data classification with greater accuracy, and less error rate. Thus, it can be concluded that this research work meets the objectives framed and can be used by meteorological department, marine scientists, fishermens, and mariners.

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